Abstracts

Oral 9

Exposure assessment

O9.1 EVALUATION OF WORKERS' EXPOSURE TO METHYLENE DIPHENYL DIISOCYANATE IN AN AUTOMOBILE MANUFACTURING COMPANY, IRAN

S. J. Shahtaheri[1], H. Kakooei[1], H. Karbasi[1]. [1]*School of Public Health, Tehran University of Medical Sciences, Tehran, Iran*

Introduction: Methylene diphenyl diisocyanate (MDI) is one of the most important industrial compounds used to produce flexible polyurethane foams, sealants, and adhesives, and some other synthetic products, causing adverse effect on workers. This study has aimed to evaluate occupational exposure to such compound.
Methods: Through this investigation, a cross sectional evaluation of exposures to MDI among 39 employees, working in the window fixation and window glue, in an automobile manufacture was performed. Workers were interviewed, using a health work practice questionnaire, worksite inspections. Exposure assessment was conducted for both case and control groups. Control group of 117 unexposed employees, working in other workstations were also interviewed. Personal inhalation exposure, while using MDI, was done, using MDHS 49 (method for determination of hazardous substance, October 1985), in which, after sampling and sample preparation, MDI was determined by UV-VIS at 590 nm as well as assessing the lung function by using spirometer.
Results: The average concentration of MDI in the window fixation, and window glue were 34.53 and 27.37 mg/m^3 respectively which was lower than the TLV recommended by ACGIH (51 mg/m^3). Results also showed that, respiratory symptoms such as sputum, cough, wheezing in the exposed group were significantly different compare to the unexposed group ($p<0.05$). The mean value of pulmonary function parameters showed that, FVC, FEV1, FEV1/FVC, and PEP in case group were lower than the control group ($p<0.05$). The results also showed that, exposed workers who were in higher and lover values than the average concentration of MDI (31.22 mg/m^3) had a significant difference with the symptoms from difficulty in respiratory system, eyes, mental, and FVC, and FEV.
Conclusion: From the results obtained, it can be concluded that, under TLV values there are still some systematic disorders in workers exposed to MDI, therefore, it seems that, for developing occupational standard values more scientific considerations needed to be taken into account.

O9.2 MORE OR LESS EXPOSED DURING THE FOLLOW UP OF THE ECRHS

H. Kromhout[1], R. Vermeulen[2], J.-P. Zock[3], M. Kogevinas[3] and for the ECRHS II Occupational Working Group. [1]*IRAS, Utrecht University, Utrecht, the Netherlands;* [2]*OEEB, National Cancer Institute, Rockville, MD, USA;* [3]*URRA, IMIM, Barcelona, Spain*

Introduction: Trends in exposure to biological and mineral dust and gases and fumes during the follow up of the European Community Respiratory Health Survey (ECRHS) were studied among 9144 participants from 26 study centres to evaluate health related selection processes.
Methods: Each individual's job history during follow up was translated with a general JEM into an exposure history. With each individual contributing at least 6 years of follow up, this resulted in 660 000 person-months of exposure. Trends were looked for in general and after stratifications by age group, sex, smoking habits, socioeconomic status (SES), and respiratory health indicators at baseline (ECRHS I). In addition, predictors were identified for changes in exposure during follow up.
Results: Exposure increased during early follow up, particularly among younger age groups. Smoking status and SES were strong predictors of both increase and decrease (not clear) of exposure to dusts and gases and fumes. Women were slightly more exposed to biological dusts than men (10%), but men were 3–4 times higher exposed to mineral dusts and gases and fumes than women. Large differences between centres in (trends of) average exposure were apparent. Individuals reporting chronic cough with phlegm were higher exposed to mineral dust (and gases and fumes) at baseline, but this difference disappeared towards end of follow up. A healthy worker selection effect was most pronounced for individuals with chronic bronchitis. For individuals with physician diagnosed asthma a small non-significant healthy worker effect was present.
Conclusion: Occupational exposures in the general population appear to have been affected by temporal changes during the last decade. Main predictors of these changes have been identified, which include respiratory health status.

O9.3 GRAPHICAL EVALUATION TOOL FOR RETROSPECTIVE QUANTITATIVE EXPOSURE ASSESSMENT AND ASSIGNMENT

W. Fransman[1], B. Miller[2], F. Hurley[2], D. Heederik[1], H. Kromhout[1]. [1]*IRAS, Utrecht University, Utrecht, the Netherlands;* [2]*Institute of Occupational Medicine, Edinburgh, UK*

Introduction: Quantitative assessment of historical exposure in both cohort and nested case control studies is slowly but unquestionably becoming the norm in occupational epidemiology. It has been shown that accurate exposure assessment and assignment are crucial for establishing exposure-response relations. Inaccurate exposure assessment as a result of, for instance, extrapolations from periods with measurements to periods without measurements will result in these relations staying undetected or will lead to biased exposure-response relations. Formal methods for evaluating the quality of exposure assessment are so far lacking. We propose a graphical method that will provide insight in coverage of exposure assessment information in an epidemiological study over the relevant period of observation. This method can be used to look for differences in assessed and assigned estimates of historical exposure that might explain the lack of consistency among studies addressing similar health effects and exposures.
Methods: Graphs showing the distribution of person-years of observation against calendar year overlaid with the distribution of exposure measurements used in the exposure assessment, will give insight into the person-years for which extrapolation was needed. Distribution of cumulative exposure estimates against calendar year will show when (highest) exposed workers accumulated their exposure and what the reliability of that assessed exposure was.
Results: Applying the method to three case control studies on benzene exposure and leukaemia shed light on the quality of the exposure assessment and provided insight in the lack of consistency in the epidemiological results.
Conclusion: With quantitative exposure assessment becoming the norm in occupational epidemiology, formal methods to evaluate the quality of the exposure assessment and assignment are becoming a necessity. The proposed method of graphical evaluation of key parameters like person years of observation, available measurements, and cumulative exposure estimates against calendar year should be seen as a necessary first step.

O9.4 SPECIFICITY OF EXPOSURE METRIC IN DOSE-RESPONSE RELATIONS IN A RETROSPECTIVE ALUMINUM SMELTER COHORT

M. C. Friesen[1], P. A. Demers[1], J. J. Spinelli[2], M. Lorenzi[2], N. D. Le[2]. [1]*Occupational & Environmental Hygiene, University of British Columbia;* [2]*BC Cancer Agency, Canada*

Introduction: Benzo(a)pyrene (BaP) has been suggested as a better indicator of the carcinogenic potential of aluminium smelter fumes over the more commonly measured coal tar pitch volatiles (CTPV). We evaluated the dose-response relations between cancer incidence and cumulative exposure to BaP and CTPV in a retrospective aluminum smelter cohort.
Methods: The cohort of 6444 men employed at least three years between 1954–2000 was linked to national cancer registries. Quantitative BaP and CTPV job exposure matrices (JEM) were derived from a multistage process that included statistical modelling of personal measurements (2579 CTPV; 1195 BaP) and extrapolation to jobs and time periods not measured. A second BaP JEM was constructed by applying the ratio of BaP in CTPV (662 paired measurements) in each

job/pitch type to the CTPV JEM. Dose-response was assessed using Poisson regression.
Results: Cumulative CTPV exposure was highly correlated with cumulative BaP exposure (BaP Model JEM, $r=0.94$; BaP Ratio JEM, $r=0.96$). On average, BaP Ratio cumulative exposures were 1.8 times higher than the BaP model ($r=0.91$), but the ratio varied by decade of hire (from 1.9 for 1950s to 0.9 for 1990s). For lung and bladder cancer, dose-response relations were more consistently monotonic with cumulative BaP Model exposures; although a significant trend across categories was observed for all exposure metrics with both no lag and 20 year lag. For lung cancer with 20 year lag, the relative risk for the highest cumulative exposure category was 2.3, 2.0, and 2.2 for BaP Model, BaP Ratio, and CTPV, respectively (>8 v <0.06 mg/m^3 year for CTPV, >80 v <0.6 μg/m^3 year for BaP). For bladder cancer with 20 year lag, the relative risks for the highest cumulative exposure category was 2.6, 2.5, and 2.4 for BaP Model, BaP Ratio, and CTPV, respectively.
Conclusions: BaP and CTPV cumulative exposures were strongly related, but we observed distortion of the dose-response relation in the moderate categories suggesting more misclassification with CTPV and BaP Ratio cumulative exposure. Differences in the two BaP estimation approaches reflects uncertainty in the BaP/CTPV relation by pitch type in early time periods as a result of limited measurements.

O9.5 ASSESSING OCCUPATIONAL EXPOSURES TO 21 AGENTS IN A LARGE INTERDISCIPLINARY CASE CONTROL STUDY OF BLADDER CANCER IN SPAIN

M. Dosemeci[1], S. Camarero[2], C. Samanic[1], M. Kogevinas[3], D. Silverman[1], N. Malats[3], N. Rothman[1], C. Serra[4], A. Tardon[2], R. García-Clossas[5], A. Carrato[6], P. A. Stewart[1]. [1]*National Cancer Institute, Bethesda, USA;* [2]*Universidad de Oviedo, Oviedo, Spain;* [3]*Municipal Institute of Medical Research, Barcelona, Spain;* [4]*Pompeu Fabra University, Barcelona, Spain;* [5]*Hospital Universitario de Canarias, Tenerife, Spain;* [6]*Hospital General de Elche, Elche, Spain*

Introduction: We developed a state of the art exposure assessment procedure to assign occupational exposure levels to 21 hazardous agents, including diesel exhaust, PAHs, aromatic amines, asbestos, organic solvents, chromium, cadmium, arsenic, wood dust, oil mist, pesticides, herbicides, and insecticides in an interdisciplinary case control study of bladder cancer in Spain.
Methods: We conducted a hospital based case control study of bladder cancer in Spain between 1998 and 2001, including 1226 cases and 1271 controls. Lifetime occupational history was collected through a computer assisted personal interview (CAPI). In addition, we collected information on lifetime occupational exposures using job specific modules. Work histories and job specific modules were reviewed by a Spanish occupational hygienist to develop a set of questions to clarify the exposure conditions and assign levels of intensity, probability, frequency, and confidence.
Results: Prevalence of exposure to diesel exhaust was 32% with 19% at low, 9% at medium, and 4% at high intensity levels; to PAH was 38% with 27% at low, 9% at medium, and 2% at high intensity levels; to organic solvents was 20% with 13% at low, 4% at medium, and at 3% at high intensity levels; and to pesticides was 8% with 5% at low, 2% at medium, and 1% at high intensity levels. In comparison to job exposure matrix (JEM), subject specific assessment shows that 46% of street vendors (SOC 4163) have no exposure to diesel exhaust, and 42% of them were at low, 9% at medium, and 3% at high level of diesel exposure, indicating that subject specific assessment allowed us to see more exposure variability compared to using a JEM where the same exposure level is applied to all subjects with the same SOC.
Conclusions: Detailed work history information, job specific modules, and follow up questions allowed us to capture higher exposure prevalence for most of the occupational risk factors in the study.

O9.6 EXPOSURE TO DUST AND SULPHUR DIOXIDE IN THE NORWEGIAN SILICON CARBIDE INDUSTRY

S. Føreland[1,2], E. Bye[1], W. Eduard[1]. [1]*The National Institute of Occupational Health, Norway,* [2]*University of Oslo, Norway*

Introduction: Increased risk for lung cancer and other lung diseases has recently been observed among workers in the Norwegian silicon carbide industry.[1] The risk for lung cancer was three to four times higher than expected, compared to the national incidence rate. Furthermore, a nearly doubled mortality risk caused by obstructive lung diseases was also observed.[2] A relation was found between the cumulative total dust exposure and lung cancer. However, causative agents in the airborne dust could not be identified. The objective of the current project is to further explore associations between lung cancer, other lung diseases, and the exposure to the complex mixtures of particulate airborne material. This includes the identification of possible causative agents.
Methods: In this project we assessed exposure to respirable and total dust, fibres, quartz, cristobalite, non-fibrous silicon carbide dust, and sulphur dioxide (SO_2). Data were collected from three Norwegian silicon carbide production plants. Exposure measurements are performed on workers who handle raw materials, produce raw product in the furnace hall, separate raw product from unreacted material, and workers in the refinery and maintenance departments. Each plant was sampled twice to determine any variations in exposure from seasonal and process related changes. In addition, each worker was if possible sampled twice in both periods to assess intra- and interperson variability. An improved retrospective job exposure matrix (JEM) will be constructed and used in epidemiological analyses later on.
Conclusion: High exposure to fibres was found among maintenance workers and workers handling raw materials and raw product. SO_2 exposure was confined to workers in the furnace plant. The average exposure over 8 hour shift was low, however high peak exposure occurs. Exposure to respirable dust and total dust varied from low to high in all departments. Exposure data on quartz, cristobalite, and non-fibrous silicon carbide dust will also be presented.

1. **Romunstad P**, *et al.* Cancer incidence among workers in the Norwegian silicon carbide industry. *Am J Epidem* 2001;**153**: 978–86.
2. **Romunstad P**, *et al.* Non-malignant mortality among Norwegian silicon carbide smelter workers. *Occup Environ Med* 2002;**59**: 345–34.

O9.7 PARTICLE EXPOSURE ASSESSMENT FOR THE US TRUCKING INDUSTRY

T. J. Smith[1], P. Reaser[1], J. Hart[1], J. Schauer[2], F. Laden, E. Garshick[4]. [1]*Harvard School of Public Health, Boston, USA;* [2]*University of Wisconsin, Madison, WI, USA;* [4]*Veterans Administration Hospital, Brockton, MA, USA*

Introduction: Very large quantities of freight are transported on large diesel powered trucks in the US and other countries. The exposures of drivers and freight terminal personnel have not been well defined. A study is in progress to characterise the particulate exposures of these workers. Workers were represented by the Teamsters and work for four major trucking companies. This is part of a National Cancer Institute funded a cohort study of lung cancer; our cohort is 55 000 workers in 1985. The Health Effects Institute funded sampling of volatile organic compounds (VOC) in areas near truck freight terminals and in traffic.
Methods: A total of 36 large freight terminals (>100 employees) and ~50 small terminals have been selected in regional samples across the US. A large terminal was visited each month for five days with consecutive 12 hour samples: upwind and downwind of the site, the loading dock and shop areas, and full shift samples on Dockmen, Mechanics, Clerks, and Drivers. To date, ~4000 personal and location samples have been collected for PM2.5, elemental carbon, and organic carbon, plus 80 high volume particle samples for detailed chemical analysis and emission source apportionment. VOC (alkanes, alkenes, aromatics, aldehydes, and acetone) were collected with sorbent tubes. Extensive descriptive data have also been collected.
Results: Concentrations are reported as geometric mean and geometric standard deviation. Occupational exposures are a combination of local air pollution and terminal or traffic emissions. Terminal upwind values were 11.8 (2.44) μg/m^3 PM2.5, 0.6 (3.19) μg/m^3 EC, and 6.2 (1.71) μg/m^3 OC. Shop exposures were the twofold higher, followed by the freight dock which was 33% higher. Non-smoking drivers had 17.6 (2.02) μg/m^3 PM2.5, 1.1 (2.58) μg/m^3 EC, and 14.6 (1.53) μg/m^3 OC. Smoking doubled the PM2.5 and OC concentrations. Only limited VOC data are available because the sample collection has been underway for a year.
Conclusions: Although GM exposures were low, there was a wide range across terminals and driving exposures, which appears suitable for epidemiological analysis of cancer risk.